Measuring the Costs of U.S. Oil Dependence and the Benefits of Reducing It

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May 16, 2013

Project
VAN010

Overview

Timeline

- Start: October 2005
- End: Undetermined
- NA

Budget

- Total project funding
  - DOE share 100%

- Funding for FY12 $100,000
- Funding for FY13 $150,000

Barriers

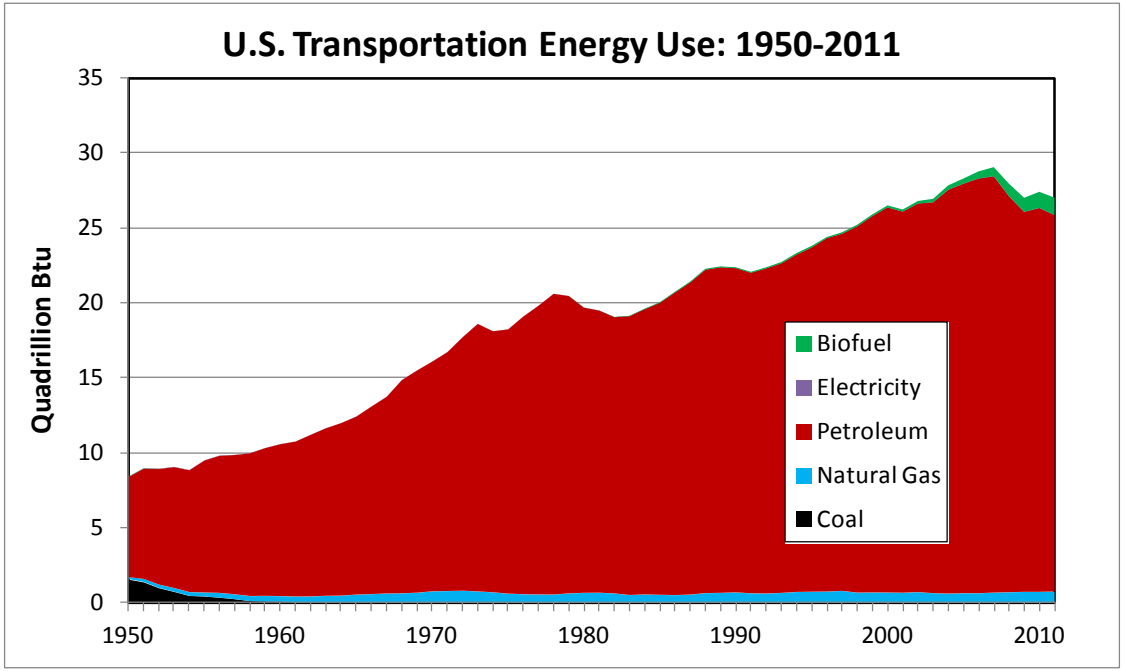
- Barriers addressed
  - Supports program portfolio management by quantifying the value of reducing future U.S. petroleum consumption and improving substitutes (p. 3.0-2).
  - Measures and explains past economic costs of oil dependence to enhance public understanding of the importance of reduced petroleum dependence (p. 1.0-5).

Partners

- University of Tennessee - *Department of Earth and Planetary Sciences*
- George Washington University
- Project lead: *ORNL*

Relevance: The OSMM estimates the cost of U.S. oil dependence and the full economic value of reducing it.

- Enhancing US energy security is a primary objective of the DOE.
- The transportation sector's oil dependence is probably the greatest threat to US energy security.
- The OSMM project tracks and explains oil dependence costs and measures the energy security benefits of vehicle efficiency and alternative fuels.



Objectives: Continued improvement of the OSMM in FY 12-13 addresses theory, calibration and analysis.

- Update and re-estimate historical costs of oil dependence from 1970 to 2012.
- Harmonize analysis of OPEC market power with calibration of OSMM.
- Develop new calibration methods capable of accommodating the sustained high price scenarios of recent AEOs.
- Re-calibrate OSMM to 2012 & 2013 Annual Energy Outlooks.
- Analyze impacts of new energy policies and technologies via simulation.

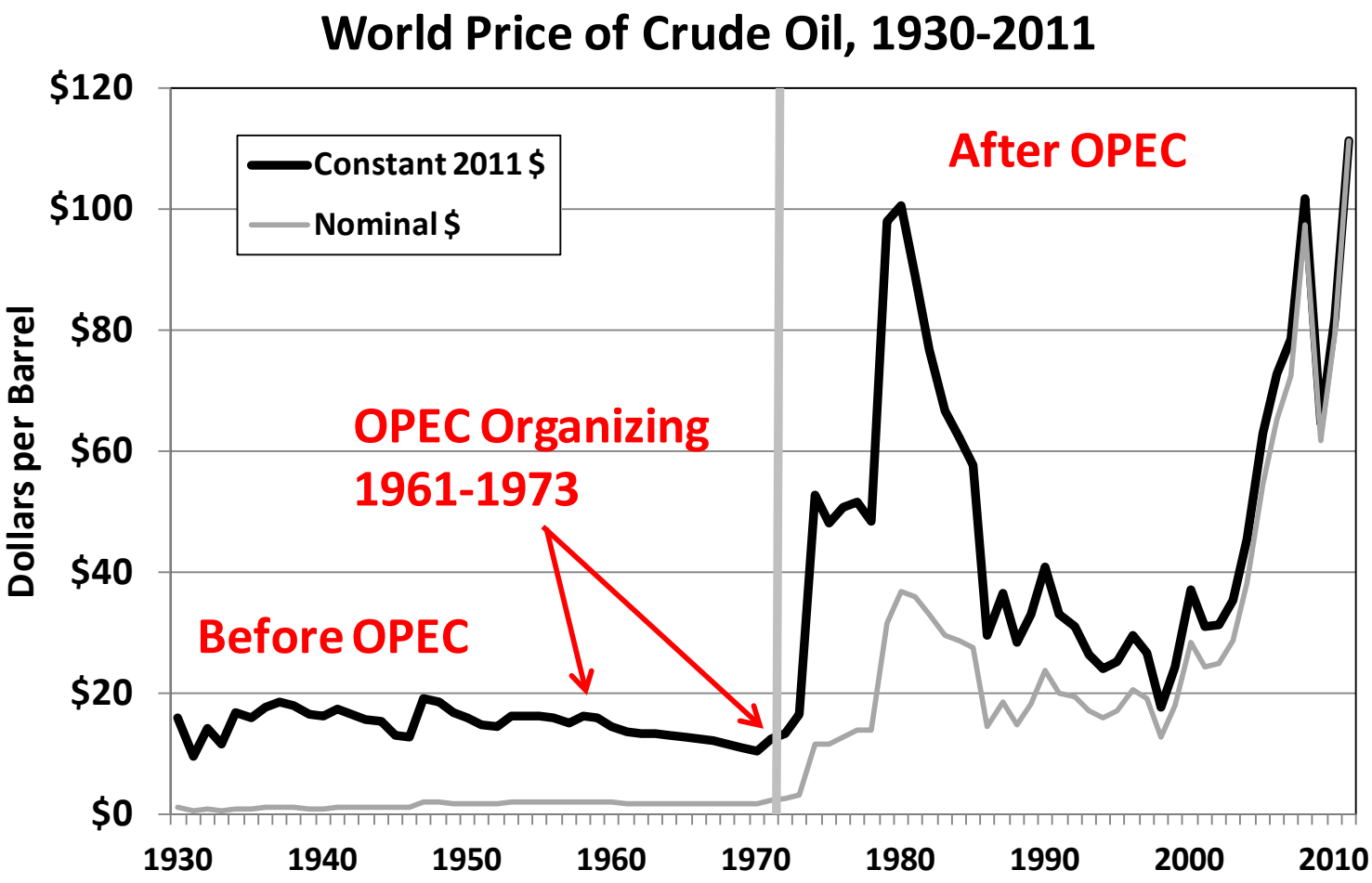
Milestones

- Harmonize OSMM and analysis of OPEC market power – July 31, 2012
- Re-estimate historical costs
  - Through 2011 – 09/15/2012
  - Through 2012 – 02/28/2013
- Implement new calibration methods – 09/31/2012
- Calibrate to 2013 AEO High, Reference and Low Oil Price Cases
- Estimate benefits of current policies in uncertain future – 04/30/2013

APPROACH: The OSMM recognizes the influence of the partial monopoly of oil-producing nation states on the world oil market.

"The real problem we face over oil dates from after 1970: a strong but clumsy monopoly of mostly Middle Eastern exporters operating as OPEC." Prof. M. Adelman, MIT, 2004.

- Algeria
- Angola
- Ecuador
- Iran
- Iraq
- Kuwait
- Libya
- Nigeria
- Qatar
- Saudi Arabia
- UAE
- Venezuela



Market dynamics are critically important:

Short- and long-run supply and demand responses to price differ by an order of magnitude!

$$P = \frac{C}{1 + \left(\frac{1}{\beta(P)} S\left(\mu(P) + 1\right) \right)}$$

P = profit maximizing price for monopolist

C = marginal cost of producing oil

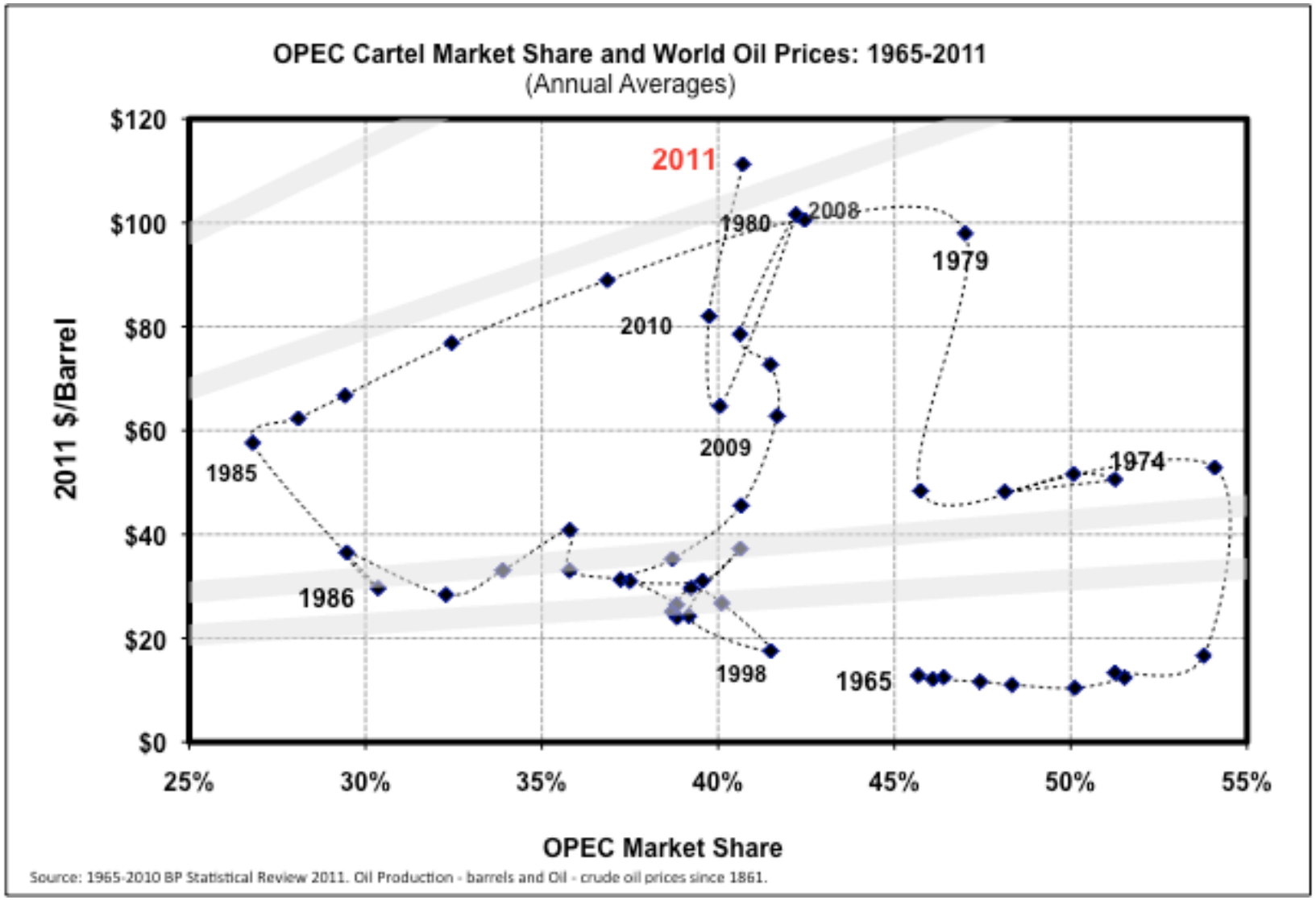
β = price elasticity of world oil demand ($\beta < 0$)

S = OPEC share of world oil market ($0 < S < 1$)

μ= non-OPEC supply response ($-1 < \mu < 0$)

Elasticity = % change in quantity / % change in price = d ln(y)/d ln(x)

In FY 12 the OSMM calibration was made consistent with an historical analysis of world oil prices, and the model's predictions were compared with those of other studies.



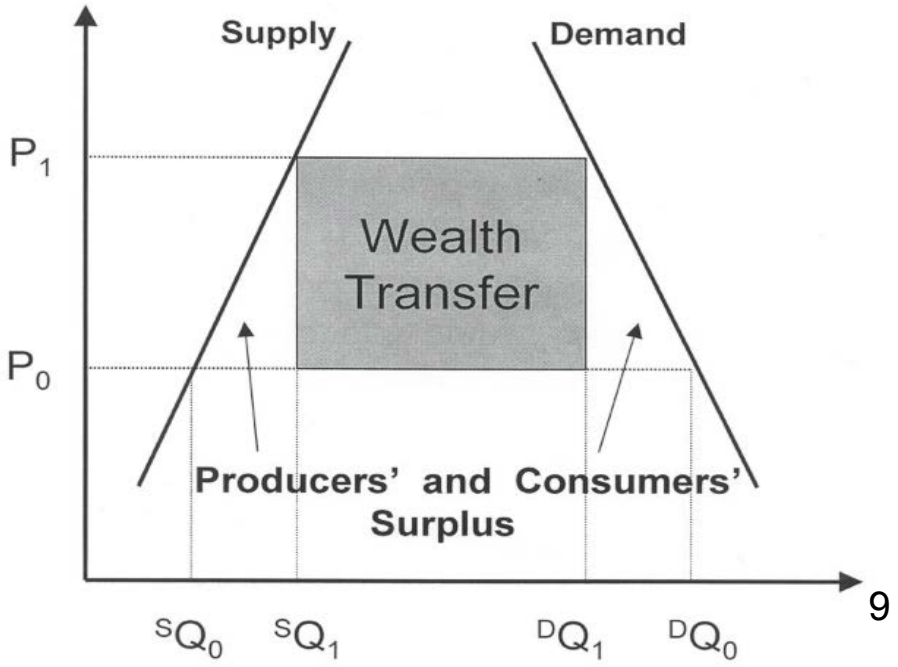
The OSMM measures 3 losses to the U.S. economy in comparison to a competitive market.

1. **Loss of potential GDP** = producers' & consumers' surplus losses in oil markets (dynamic).

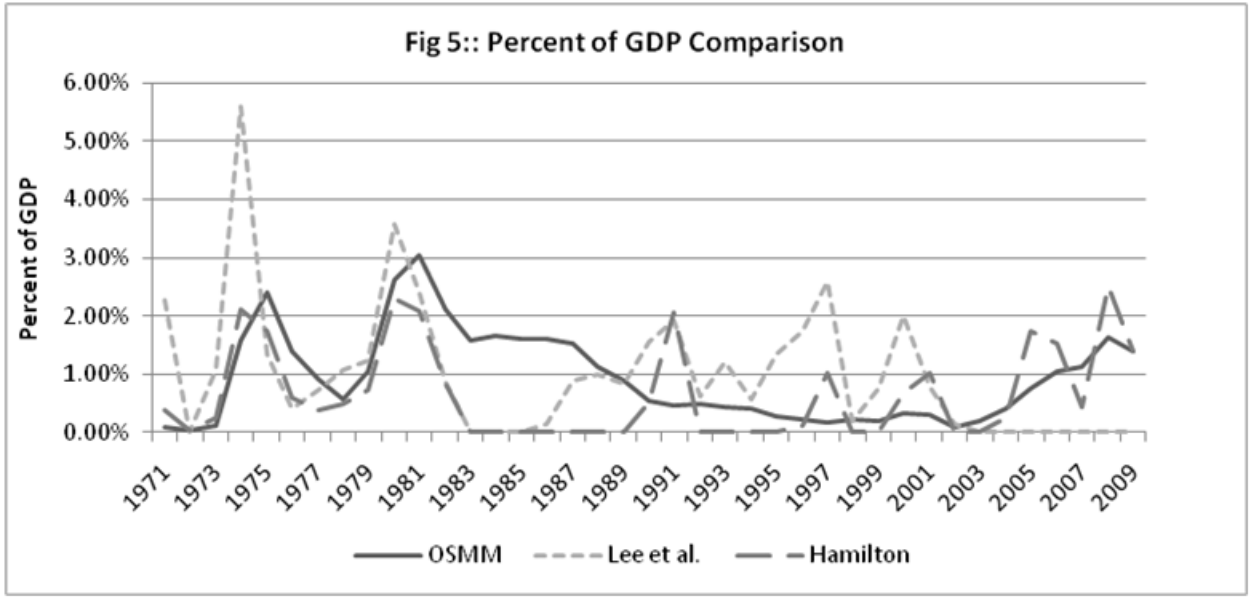
2. **Dislocation losses** of GDP due to oil price shocks.

3. **Transfer of wealth** due to monopoly pricing and price shocks (requires counterfactual competitive price).

Transfer of wealth is not a loss of GDP but a change in the ownership of GDP. It can occur in disrupted and undisrupted markets and occurs whether or not OPEC is the cause of the disruption.



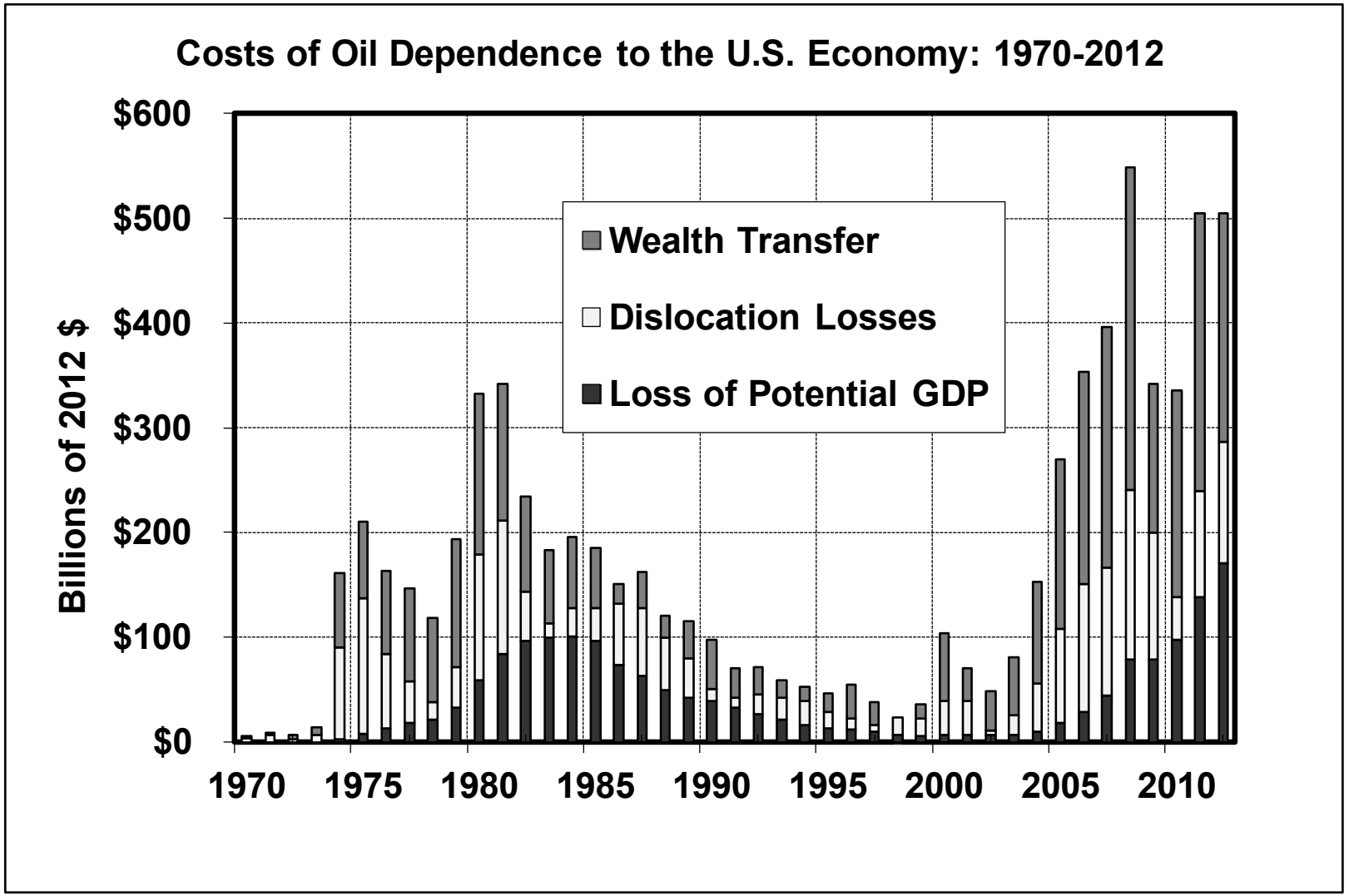
Comparisons with econometric models supported the OSMM estimates. Methodological differences cause econometric models to "see" smaller short-lived price shocks shocks the OSMM overlooks and to "miss" the negative effects of the price collapse of 1985.



Comparison of GDP Impacts during Three Significant Oil Events

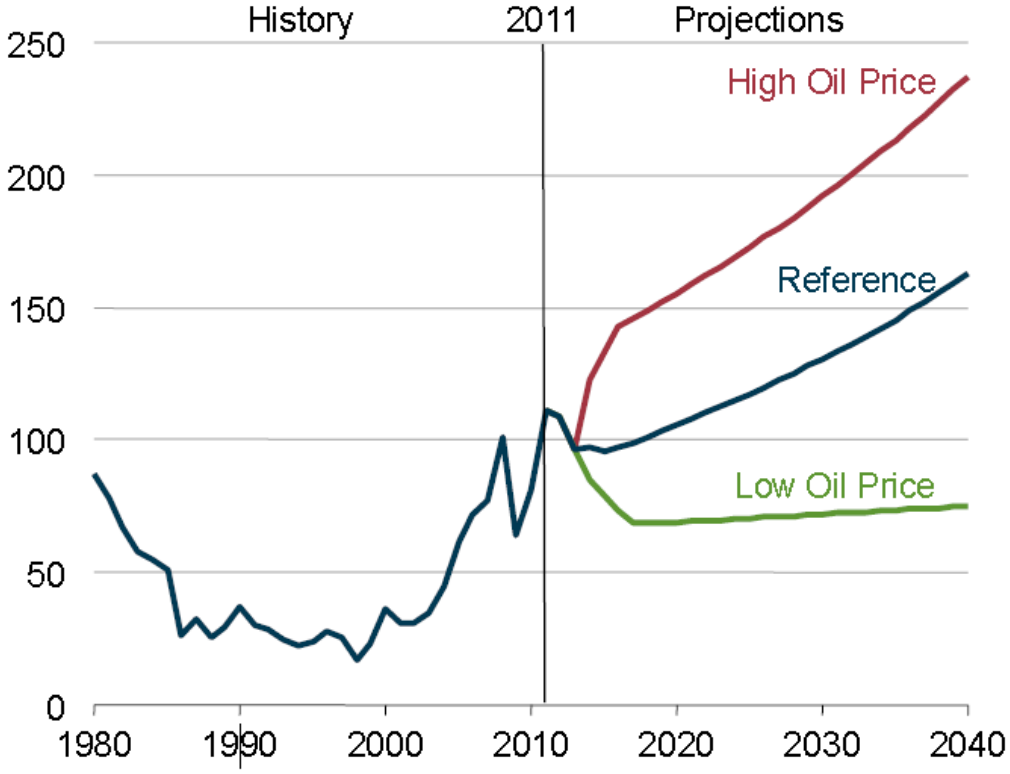
	Hamilton	OSMM	Lee, Ni and Ratti
1973-1975	$199 billion	$200 billion	$392 billion
1979-1982	$350 billion	$520 billion	$475 billion
2004-2009	$1019 billion	$828 billion	Data not available

The OSMM's estimated costs of U.S. oil dependence for 2011-12 amounted to $1 trillion.



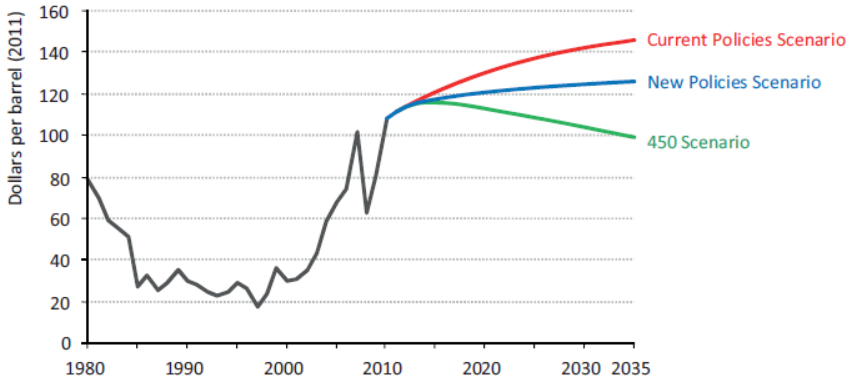
Calibration of the OSMM to AEO projections became difficult when the AEO began projecting consistently high oil prices with little market supply or demand response.

Figure 5. Average annual Brent spot crude oil prices in three cases, 1980-2040 (2011 dollars per barrel)



EIA, Annual Energy Outlook 2013 Early Release, p. 5.

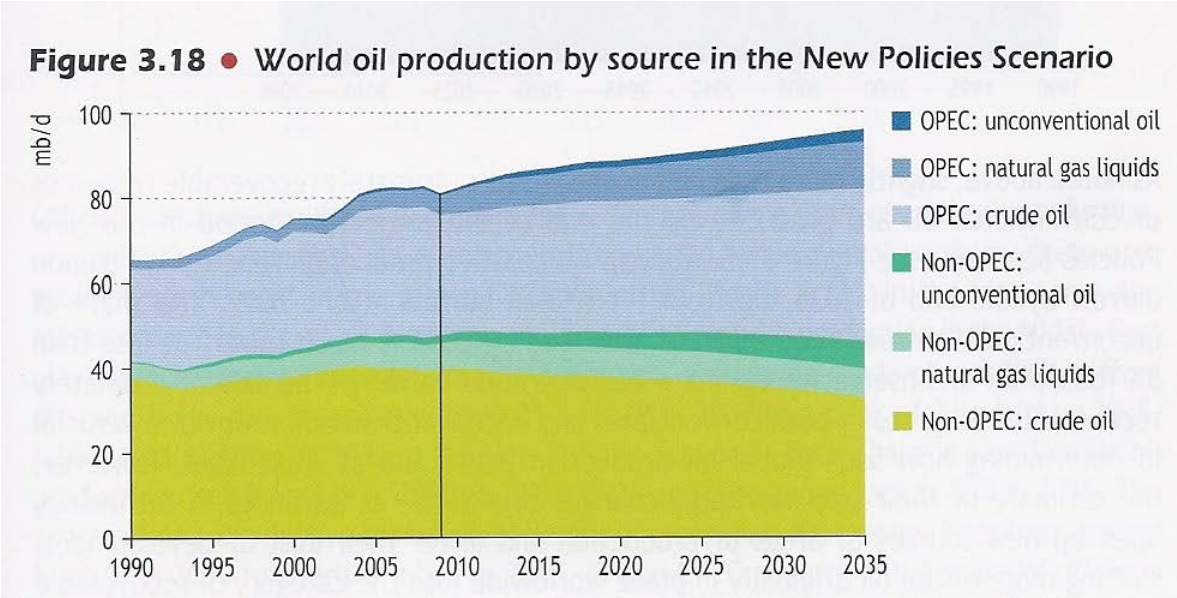
Figure 1.1 ▷ Average IEA crude oil price

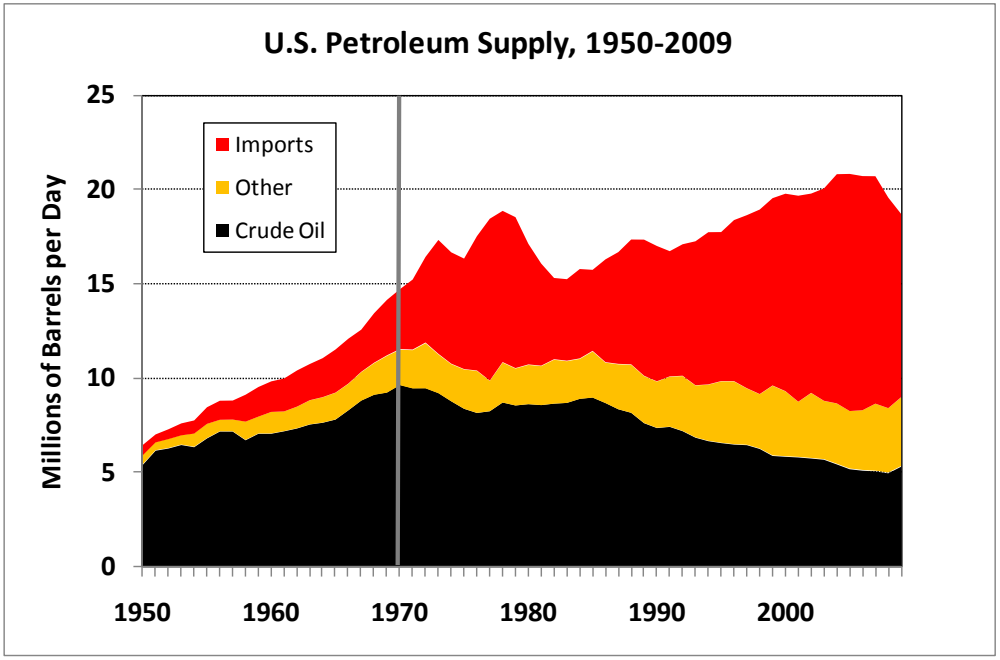


Note: In the 450 Scenario, administrative arrangements are assumed to be put in place to keep end-user prices for oil-based transport fuels at a level similar to the Current Policies Scenario.

International Energy Agency, World Energy Outlook 2012, p. 42.

OPEC's market power was strengthened by growing world demand, its increasing market share and the peaking of US crude oil production in 1970.

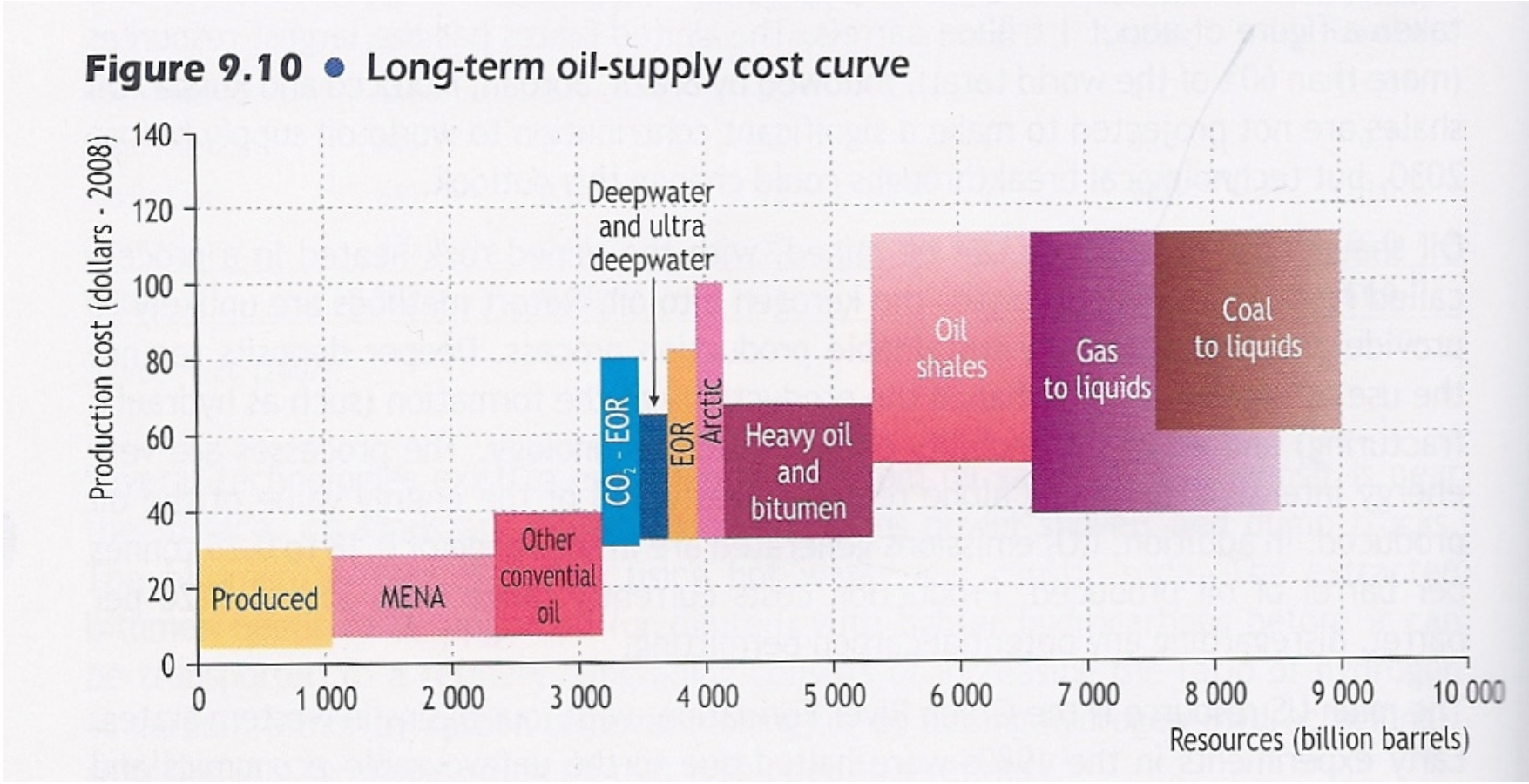




The International Energy Agency foresaw a plateau in non-OPEC conventional and unconventional oil production from now to 2030. So did BP and ExxonMobil.

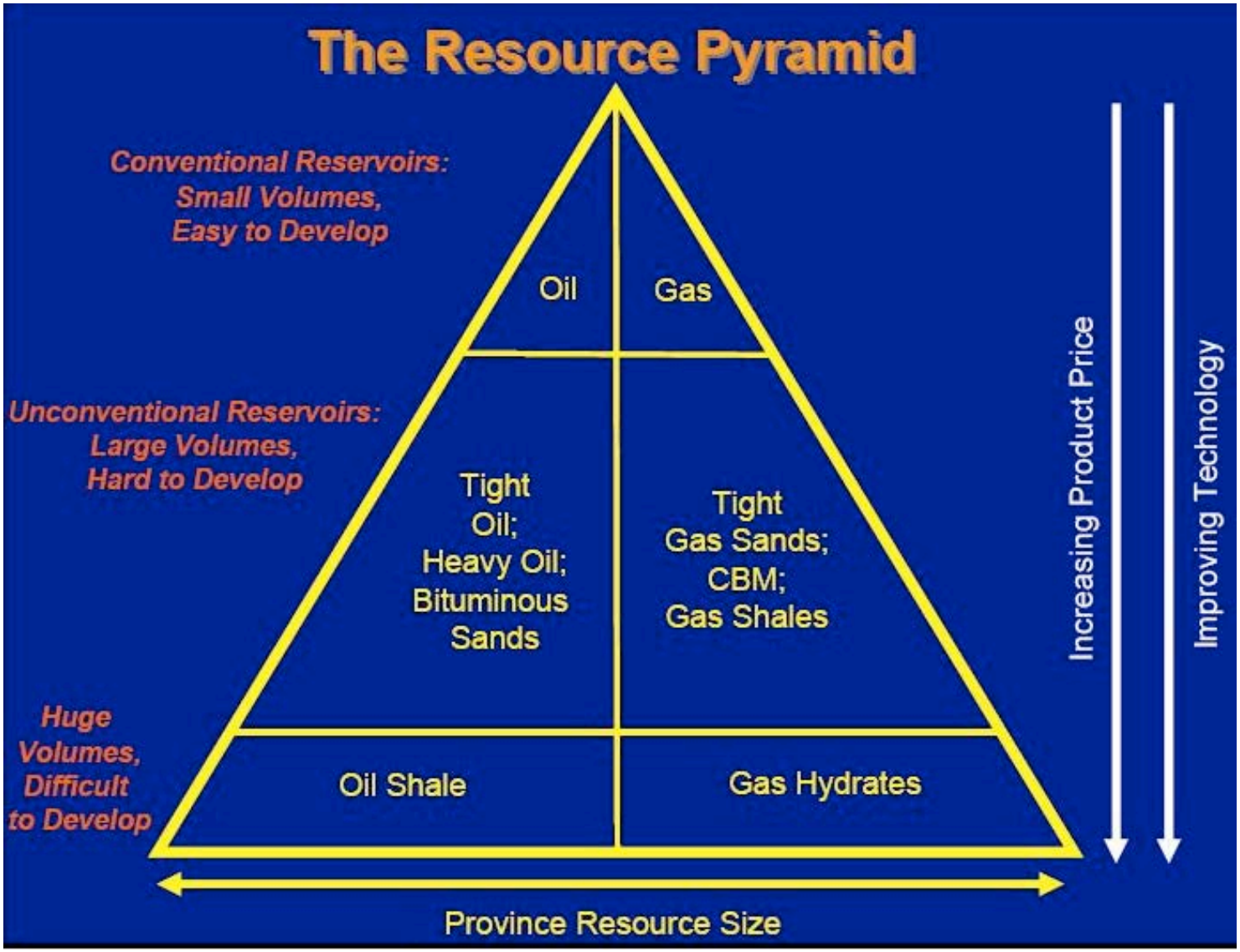
Source: Energy Information Administration, Annual Energy Review 2009, table 5.1.

If non-OPEC, conventional oil production has peaked the marginal source of supply is now unconventional petroleum at $40-$60/bbl. This is consistent with the EIA price projections but implies a new, more costly energy security problem for the U.S.

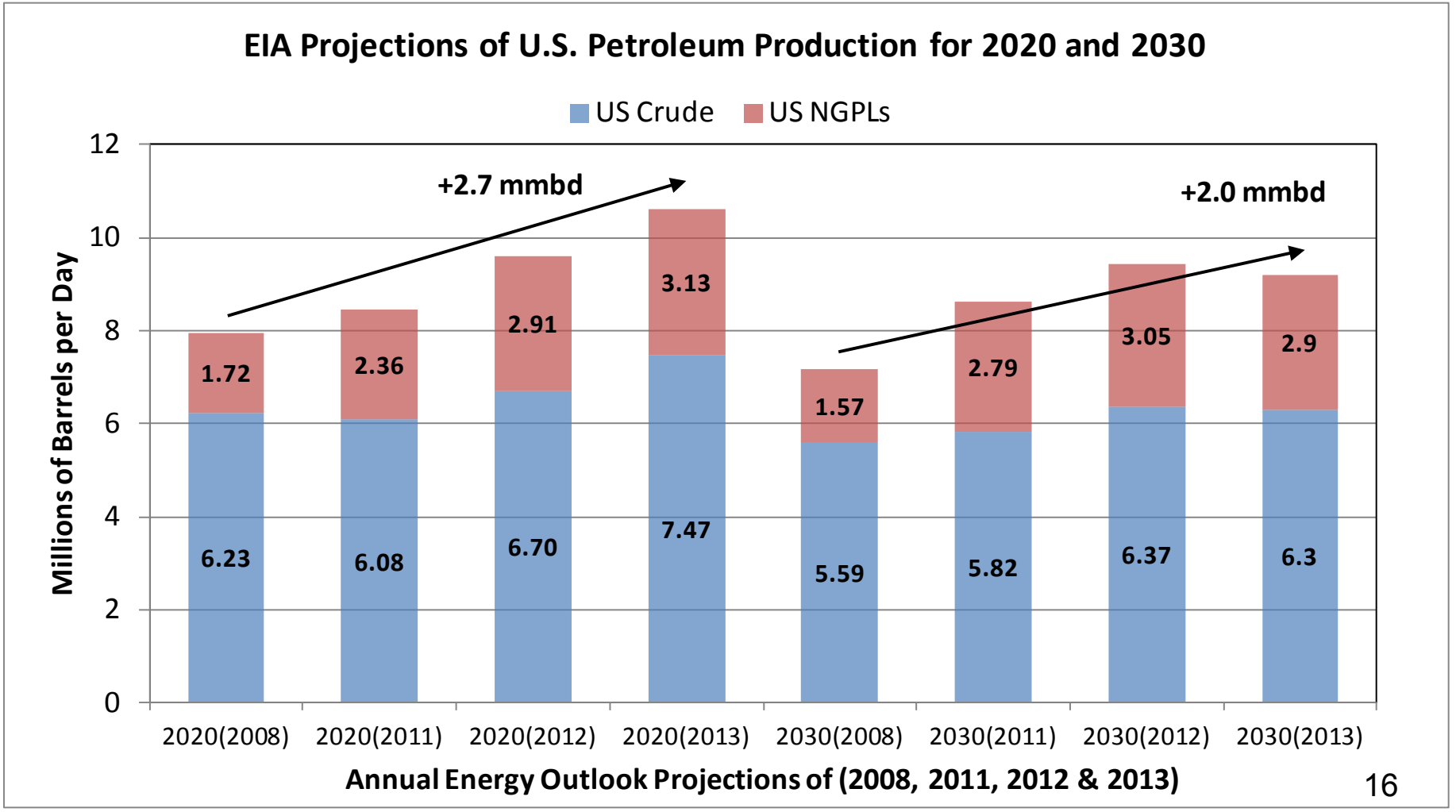


Source: International Energy Agency, World Energy Outlook 2008, OECD, Paris.

Shale gas & oil: not an unpredictable revolution in global energy resources but rather the normal response of markets and technology to high prices.



The AEO 2013 again raises U.S. petroleum liquids production estimates, largely due to shale oil and gas. Will this make us energy independent?



Energy security problem solved?

Patti Domm, CNBC.com – 2 days

US is on fast-track to energy independence, report suggests

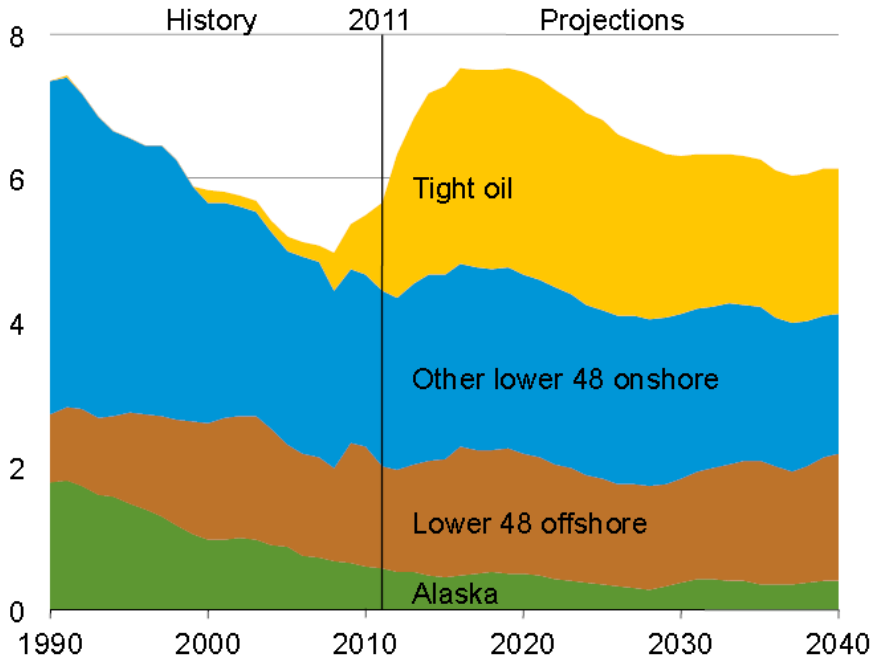
"U.S. oil and gas production is evolving so rapidly — and demand is dropping so quickly — that in just five years the U.S. could no longer need to buy oil from any source but Canada, according to Citigroup's global head of commodities research."

OPEC Survival Uncertain Amid U.S. Oil Output Growth

By Asjylyn Loder - Feb 13, 2013 10:20 AM ET

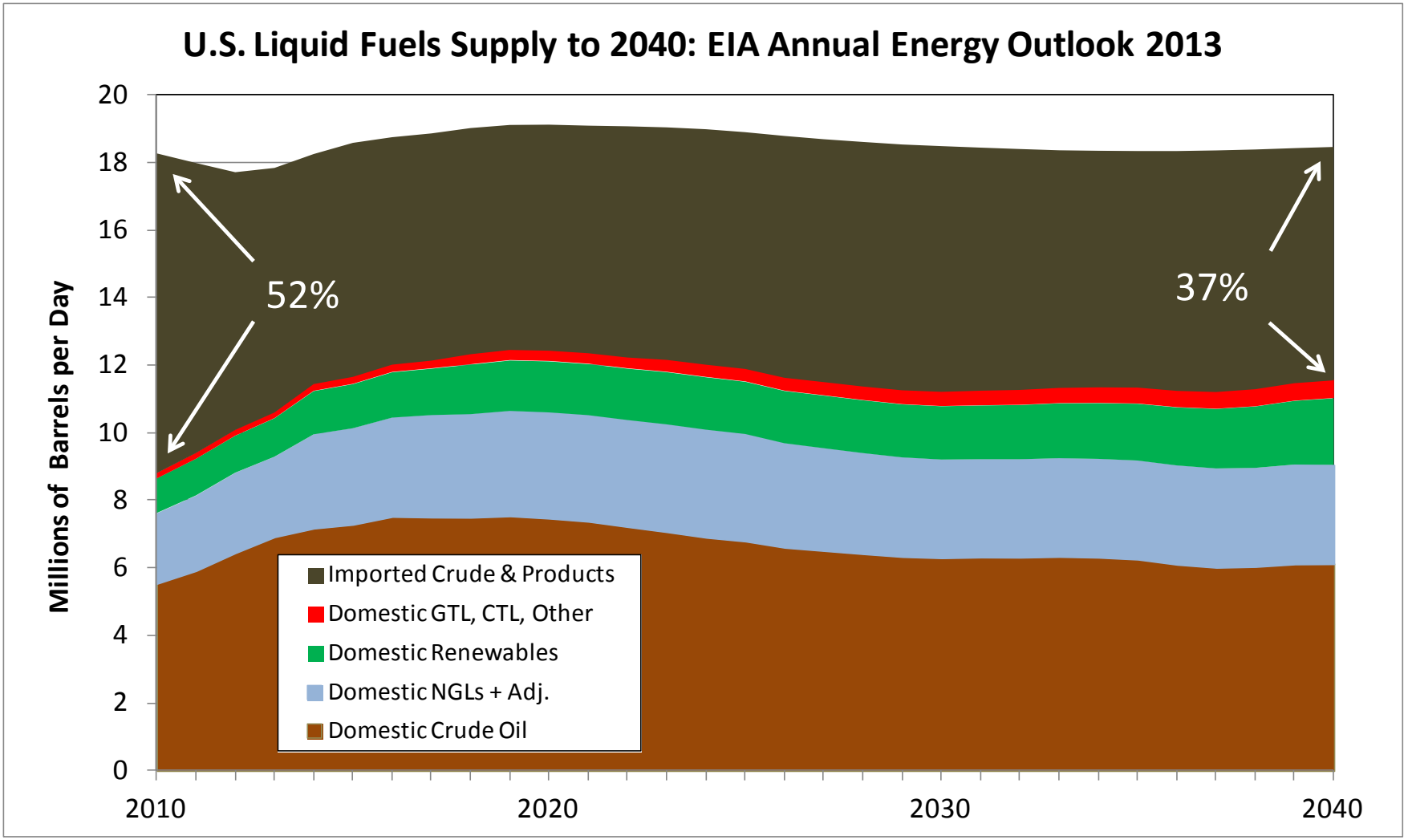
"OPEC should find it challenging to survive another 60 years, let alone another decade," analysts led by Ed Morse, global head of commodities research at Citigroup in New York, said in a report released today."

Figure 1. U.S. domestic crude oil production by source, 1990-2040 (million barrels per day)



EIA, Annual Energy Outlook 2013.

Energy Independence? In 2010 expenditures on imported oil at $81/bbl were 2.1% of GDP. In 2040 at $160/bbl import expenditures are projected to be 1.5% of GDP.



Dr. Paul Leiby (ORNL) and many others have contributed to the development of the Oil Security Metrics Model. 2012-13 collaborations are the following:

- **R. Lee (George Washington University)** used models developed by Hamilton (1983, 2003, 2005, 2009) and Lee, Ni and Ratti (1995) to develop estimates of macro-economic costs and compared those with OSMM estimates for the same years, validating the OSMM estimates.
- **Prof. Janet Hopson, University of Tennessee**, Dept. of Earth and Planetary Sciences is a co-developer of the model and data.
- **The Howard H. Baker, Jr. Center for Public Policy** at the University of Tennessee published the historical analysis as a White Paper, available at http://bakercenter.utk.edu/wp-content/uploads/2013/02/OilDependenceCosts2010-New-Cover021413.pdf .

Proposed Future Work

- On-going as of 3/15/2013 is a reassessment of the technologies and policies necessary to achieve US oil independence, as defined quantitatively by Greene (2010). This will be completed by 6/30/2013, including submission of an article for publication in a peer-reviewed journal.
- An updated version of the model documentation published in 2006 is proposed for completion by 12/15/2013 as well as a more user-friendly version of the OSMM to be made available on the internet.
- Assessments of the energy security benefits of increased energy efficiency and transition to electric drive vehicles are proposed for completion in FY 2014.

Summary

- OSMM model parameters have been harmonized with the partial monopoly theory explaining past oil market behavior (1970-2010).
- Historical oil cost estimates have been validated by comparison with those of leading econometric model of oil shock impacts on GDP.
- A White Paper documenting these accomplishments was published by the Howard H. Baker, Jr. Center for Public Policy, University of Tennessee.
- The OSMM has been modified to allow automated calibration to recent AEO projections and calibration to the 2013 AEO has been completed.
- By the date of this presentation, an assessment of the potential for US oil independence by 2030 will have been completed.

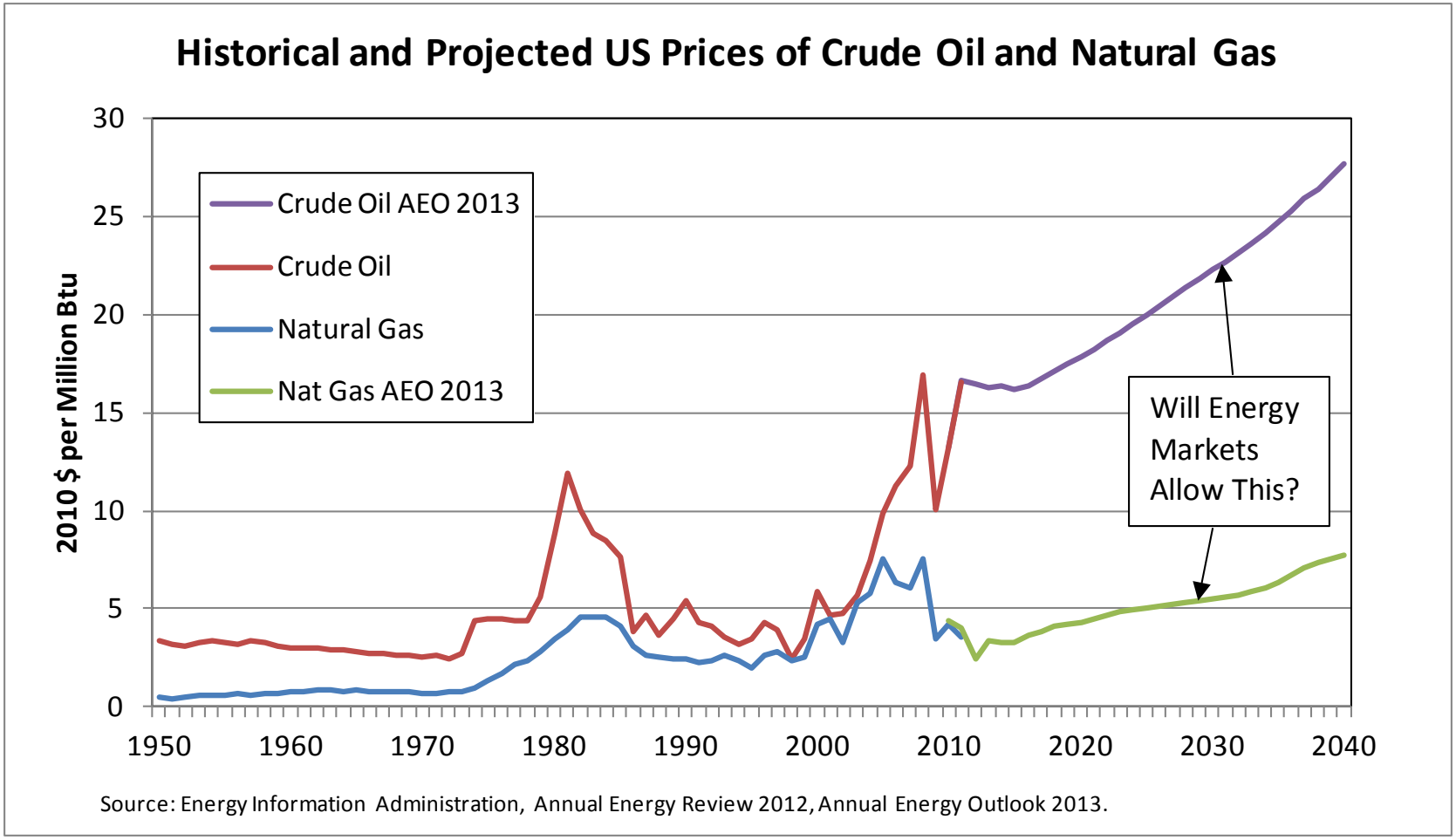
Technical Back-Up Slides

Supply and demand parameters in the OSMM were calibrated to the historical analysis of oil market behavior.

Parameter Assumptions Used in Calculating Long- and Short-run Profit-Maximizing Price Curves for the OPEC Cartel

Parameter	High Value	Low Value
	World Oil Demand	
Long-run price elasticity	-0.60	-0.45
Short-run price elasticity	-0.090	-0.068
Adjustment rate	0.15	0.15
Average, 1965-2005	Price per barrel = $36	Million barrels per day = 61.3
	Non-OPEC Oil Supply	
Long-run price elasticity	0.500	0.400
Short-run price elasticity	0.125	0.080
Adjustment rate	0.25	0.2
Average, 1965-2005	Price per barrel = $36	Million barrels per day = 36.5

Recent market developments have created great uncertainty about future fuel prices and probably some illogical projections. For example, why would anyone believe a forecast like this one?



The EIA projects shale gas will more than offset declining US natural gas production and account about half of US production in 2040.
EIA estimates exports in 2040 at 3.6 TCF

Figure 3. U.S. dry natural gas production by source, 1990-2040 (trillion cubic feet)